MULTIMEDIA UNIVERSITY TM

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, SESSION 2017/2018

EEL4126 – POWER SYSTEM OPERATION AND CONTROL

(LE)

14 OCTOBER 2017
2:30 PM – 4:30 PM
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This Question Paper consists of FOUR pages including the cover page with FOUR Questions only.

2. Answer **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

All the calculation works must be carried out in FOUR decimal points.

Question 1

A power plant has three units with the following cost characteristics:

$$C_1 = 0.0040P_1^2 + 7.20P_1 + 350 \text{ RM/h}$$
$$C_2 = 0.0025P_2^2 + 7.30P_2 + 500 \text{ RM/h}$$
$$C_3 = 0.0030P_3^2 + 6.74P_3 + 600 \text{ RM/h}$$

P_1, P_2, and P_3 are generating power in MW. The maximum and minimum loads allowable on each unit are 500 MW and 80 MW, respectively.

(a) Obtain the priority list based on full-load average production cost. [6 marks]

(b) What do you understand on Unit Commitment Problem (UCP)? [3 marks]

(c) Find the unit commitment using Priority List Algorithm if the system loads vary from 300 MW to 1300 MW in steps of 100 MW. [3 marks]

(d) Table Q1(d) shows the curve data of a power system, where each period is of 4–hour duration. The start-up cost for each unit is RM1000. Design the unit commitment of the system by using priority list obtained from Q1(a).

[13 marks]

Table Q1(d)

Time	Period 1	Period 2	Period 3	Period 4	Period 5
Load (MW)	450	900	400	800	1200

Question 2

(a) Security-constrained Optimal Power is commonly known as the combination of contingency analysis with an optimal power flow, which adjusts generation, transformer tap setting as well as other adjustments, so that no contingencies result in violation when a security analysis is run. With aids of the diagram, briefly explain the FOUR operating states in the implementation of Security-constrained Optimal Power Flow. [12 marks]

(b) A 3-bus power system is shown in Figure Q2(b).

(i) Determine the power flow in each line using DC power-flow method. The values of x_{ij} are in per unit on 100 MVA base. [11 marks]

(ii) With the results obtained from Part (b)(i), redraw the 3-bus power system and shows clearly the direction of power flow on each line. [2 marks]

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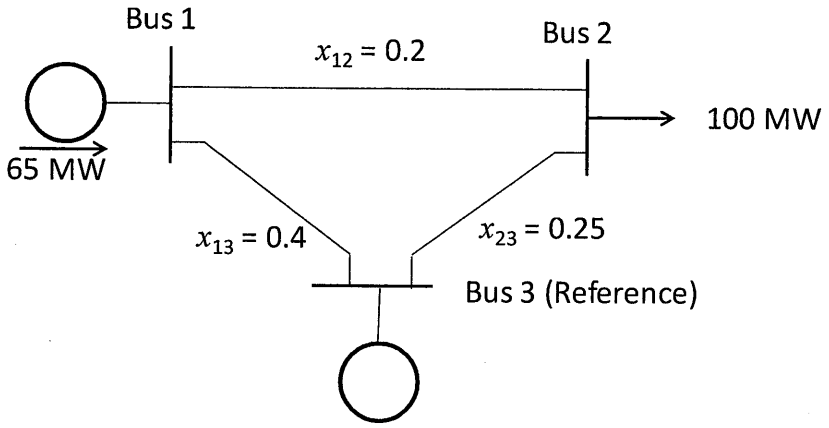

Figure Q2(b)

Question 3

(a) Figure Q3(a) shows the block diagram of governor model used in a power system.

(i) What is the function of *Isochronous* governor? [2 marks]

(ii) Briefly explain the working principle of the speed-governing mechanism shown in the figure. How the system works to control the steam injection to the prime mover, in order to meet the changes on the load demand?

[9 marks]

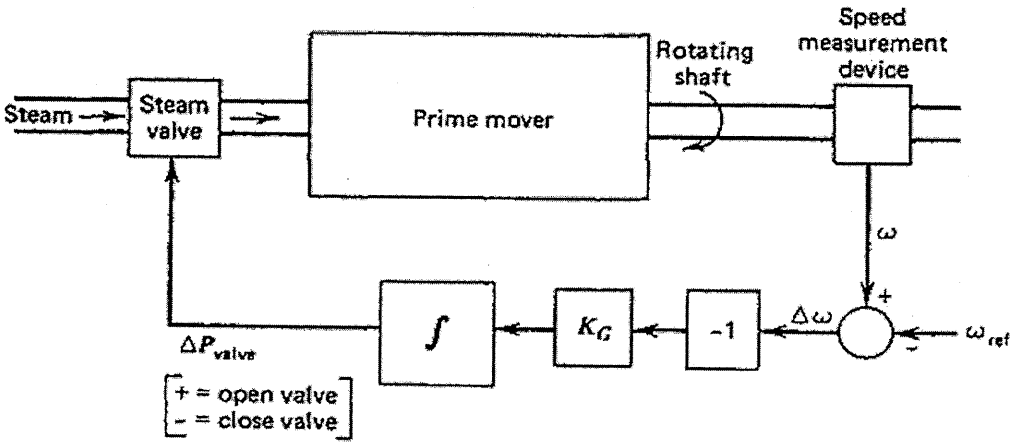

Figure Q3(a)

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(b) Two generators and a load are connected to a bus. The MVA rating and the speed droop R of each generator are given below.

Generator	MVA rating	R (per unit on generator base)
1	200	0.01
2	250	0.02

The initial generation in unit 1 is 100 MW and in unit 2 is 300 MW. The system frequency is 50 Hz. Take 500 MVA as the base, determine

(i) the new system frequency, [8 marks]

(ii) the new generation in each unit for a 100 MW load increase. [6 marks]

All the assumption(s) made in your calculation must be stated clearly.

Question 4

(a)

(i) What is the function of Automatic Voltage Regulator (AVR) in a power system? [2 marks]

(ii) Sketch the simplified model of AVR and briefly explain on the working principle of the system. [11 marks]

(b) The fuel-cost functions of three thermal power plants in \$/h are:

$$C_1 = 500 + 5.3\,P_1 + 0.004P_1^2$$
$$C_2 = 500 + 5.5\,P_2 + 0.006P_2^2$$
$$C_3 = 500 + 5.8\,P_3 + 0.009P_3^2$$

where P_1, P_2, and P_3 are in MW. With the following generator limits:

$200\ \text{MW} \le P_1 \le 450\ \text{MW}$; $150\ \text{MW} \le P_2 \le 350\ \text{MW}$; $100\text{MW} \le P_3 \le 225\ \text{MW}$

Find the optimal dispatch and the total cost for thermal plants when the total load is 975 MW. [12 marks]

End of Paper.